

REMARKS

Claims 1 through 20 are currently pending in the application.

This amendment is in response to the Office Action of March 24, 2004.

Information Disclosure Statement(s)

Applicants note the filing of two Information Disclosure Statements herein on February 24, 2004 and March 11, 2004 and note that copies of the PTO-1449s were not returned with the outstanding Office Action. Applicants respectfully request that the information cited on the PTO-1449s be made of record herein.

Claim Objections

Claims 1 through 20 are objected to due to informalities in the claim language. Appropriate correction has been made. Support for the amendments to the claims is found in the specification, page 8, paragraph [0026].

Double Patenting Rejection Based on U.S. Patents 6,632,736; 6,291,340 and 5,723,382

Claims 1 through 20 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1 through 10 of U.S. Patent 6,632,736; claims 1 through 40 of U.S. Patent 6,291,340 and claims 1 through 10 of U.S. Patent 5,723,382.

In order to avoid further expenses and time delay, Applicants elect to expedite the prosecution of the present application by filing Terminal Disclaimers to obviate the double patenting rejections in compliance with 37 C.F.R. §1.321 (b) and (c). Applicants' filing of the Terminal Disclaimers should not be construed as acquiescence of the Examiner's double patenting or obviousness-type double patenting rejections. Attached are the Terminal Disclaimers and accompanying fee.

35 U.S.C. § 102(b) Anticipation Rejections

Anticipation Rejection Based on Dean (WO 86/01640)

Claims 1 through 5, 11 and 15 are rejected under 35 U.S.C. § 102(b) as being anticipated by Dean (WO 86/01640).

Applicants assert that a claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.

Verdegaal Brothers v. Union Oil Co. of California, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

Applicants further assert that the identical invention must be shown in as complete detail as is contained in the claim. *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

After carefully considering the cited prior art, the rejections, and the Examiner's comments, Applicants have amended the claimed invention to clearly distinguish over the cited prior art.

Turning to the Dean reference, a diffusion barrier layer is provided comprising titanium carbonitride formed in a chemical-vapor-deposition process. A CVD-deposited layer of the type designated by TiC_xN_y is formed wherein an analysis of the layers indicates that the ratio of x and y are each equal to or approximately equal to 1. More generally, in such layers the ratio is $0.8 < x > 1.2$ and $0.8 < y > 1.2$.

Applicants assert that the Dean reference does not and cannot anticipate under 35 U.S.C. § 102 the presently claims inventions of presently amended independent claims 1 and 11 because the Dean reference does not identically describe, either expressly or inherently, each and every element of the claimed inventions in as complete detail as set forth in the claims.

Applicants assert that the Dean reference does not identically describe the elements of the presently claimed inventions of presently amended independent claims 1 and 11 calling for “depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1, the amorphous- titanium carbonitride film lining at least a portion of the sidewall of the contact opening overlaying at least a portion of the titanium metal layer covering the at least a portion of the silicon region exposed by the contact opening”. Applicants assert that the Dean reference has no description whatsoever, either express or inherent, of depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1. In fact, in contrast to the presently

claimed inventions of presently amended independent claims 1 and 11, the Dean reference describes the range of nitrogen atoms to carbon atoms as $0.8 < y > 1.2$ and $0.8 < x > 1.2$, which is clearly not within the range of 5:1 to 10:1 as clearly set forth in presently amended independent claims 1 and 11..

Applicants assert that the use of the words “amorphous” and “virtually no” in the claim language are supported by the specification, page 8, paragraph [0026] having the meanings thereof that the amorphous titanium carbonitride film has illustrated in the X-ray spectrum illustrated in drawing FIG. 2 and no crystal titanium nitride is detectable in the amorphous titanium carbonitride film using an X-ray spectrum having no characteristic titanium nitride peaks as is shown in drawing FIG. 2. The Dean reference has no such description of a film therein. Further, Applicants assert that the film of the Dean reference does not contain inherently any such description because the range of nitrogen to carbon atoms is not within the range set forth in the presently claimed inventions and the specification.

Therefore, presently amended independent claims 1 and 11 are allowable as well as dependent claims 2 through 10 and 12 through 20 therefrom.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on Dean et al. (WO 86/01640) in view of Nulman et al. (U.S. Patent No. 5,242,860)

Claims 7, 8, 17 and 18 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dean et al. (WO 86/01640) in view of Nulman et al. (U.S. Patent No. 5,242,860). Applicants respectfully traverse this rejection, as hereinafter set forth.

Applicants further submit that to establish a *prima facie* case of obviousness under 35 U.S.C. § 103 three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Third, the cited prior art reference must teach or suggest all of the claim limitations. Furthermore, the suggestion to make the claimed

combination and the reasonable expectation of success must both be found in the prior art, and not based on Applicants' disclosure.

After carefully considering the cited prior art, the rejections, and the Examiner's comments, Applicants have amended the claimed invention to clearly distinguish over the cited prior art.

Again, turning to the Dean reference, a diffusion barrier layer is taught or suggested comprising titanium carbonitride formed in a chemical-vapor-deposition process. A CVD-deposited layer of the type designated by TiC_xN_y is formed wherein an analysis of the layers indicates that the ratio of x and y are each equal to or approximately equal to 1. More generally, in such layers the ratio is $0.8 < x < 1.2$ and $0.8 < y < 1.2$.

The Nulman et al. reference teaches or suggests the annealing of a titanium layer over a silicon surface, a titanium nitride layer of the titanium layer, a second titanium layer over the titanium nitride layer used as a barrier layer. The titanium nitride layer having crystalline structure.

Applicants assert that any combination of the Dean reference and Nulman et al reference does not and cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claims 1 and 11 because, at the very least, any combination of such cited prior art fails to teach or suggest all of the claim limitations. Applicants assert that any combination of the Dean reference and the Nulman et al. reference fails to teach or suggest the claim limitations of presently amended independent claims 1 and 11 calling for ““depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1, the amorphous- titanium carbonitride film lining at least a portion of the sidewall of the contact opening overlaying at least a portion of the titanium metal layer covering the at least a portion of the silicon region exposed by the contact opening”. Applicants assert that neither the Dean reference nor the Nulman et al. reference has any teaching or suggestion whatsoever of depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium

carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1.

Therefore, any combination of the Dean reference and the Nulman et al. reference cannot and does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claims 1 and 11. Accordingly, presently amended independent claims 1 and 11 are allowable as well as dependent claims 2 through 10 and 12 through 20 therefrom.

Obviousness Rejection Based on Dean et al. in view of Dixit et al. (U.S. Patent No. 4,960,732)

Claims 6, 7, 16 and 17 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dean et al. (WO 86/01640) in view of Dixit et al. (U.S. Patent No. 4,960,732). Applicants respectfully traverse this rejection, as hereinafter set forth.

Applicants further submit that to establish a *prima facie* case of obviousness under 35 U.S.C. § 103 three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Third, the cited prior art reference must teach or suggest all of the claim limitations. Furthermore, the suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on Applicants' disclosure.

After carefully considering the cited prior art, the rejections, and the Examiner's comments, Applicants have amended the claimed invention to clearly distinguish over the cited prior art.

Again, turning to the Dean reference, a diffusion barrier layer is taught or suggested comprising titanium carbonitride formed in a chemical-vapor-deposition process. A CVD-deposited layer of the type designated by TiC_xN_y is formed wherein an analysis of the layers indicates that the ratio of x and y are each equal to or approximately equal to 1. More generally, in such layers the ratio is $0.8 < x < 1.2$ and $0.8 < y < 1.2$.

The Dixit et al. reference teaches a tungsten and doped polysilicon plug or a uniform dopant distribution as well as annealing a Ti/TiN layer to form a silicide.

Applicants assert that any combination of the Dean reference and Dixit et al reference does not and cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claims 1 and 11 because, at the very least, any combination of such cited prior art fails to teach or suggest all of the claim limitations. Applicants assert that any combination of the Dean reference and the Dixit et al. reference fails to teach or suggest the claim limitations of presently amended independent claims 1 and 11 calling for ““depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1, the amorphous- titanium carbonitride film lining at least a portion of the sidewall of the contact opening overlaying at least a portion of the titanium metal layer covering the at least a portion of the silicon region exposed by the contact opening”. Applicants assert that neither the Dean reference nor the Dixit et al. reference has any teaching or suggestion whatsoever of depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1.

Therefore, any combination of the Dean reference and the Dixit et al. reference cannot and does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claims 1 and 11. Accordingly, presently amended independent claims 1 and 11 are allowable as well as dependent claims 2 through 10 and 12 through 20 therefrom.

Obviousness Rejection Based on Dean et al. in view of Korman (U.S. Patent No. 4,998,151)

Claims 9, 10, 12 through 14, 19 and 20 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dean et al. (WO 86/01640) in view of Korman et al. (U.S. Patent No. 4,998,151).

Applicants respectfully traverse this rejection, as hereinafter set forth.

Applicants further submit that to establish a *prima facie* case of obviousness under 35 U.S.C. § 103 three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Third, the cited prior art reference must teach or suggest all of the claim limitations. Furthermore, the suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on Applicants' disclosure.

After carefully considering the cited prior art, the rejections, and the Examiner's comments, Applicants have amended the claimed invention to clearly distinguish over the cited prior art.

Again, turning to the Dean reference, a diffusion barrier layer is taught or suggested comprising titanium carbonitride formed in a chemical-vapor-deposition process. A CVD-deposited layer of the type designated by TiC_xN_y is formed wherein an analysis of the layers indicates that the ratio of x and y are each equal to or approximately equal to 1. More generally, in such layers the ratio is $0.8 < x < 1.2$ and $0.8 < y < 1.2$.

The Korman reference teaches forming a TiSix layer which is rapid thermally annealed.

Applicants assert that any combination of the Dean reference and Korman reference does not and cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claims 1 and 11 because, at the very least, any combination of such cited prior art fails to teach or suggest all of the claim limitations. Applicants assert that any combination of the Dean reference and the Korman reference fails to teach or suggest the claim limitations of presently amended independent claims 1 and 11 calling for ““depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1, the amorphous- titanium carbonitride film lining at least a portion of the sidewall of the contact opening overlaying at least a portion of the titanium metal layer covering

the at least a portion of the silicon region exposed by the contact opening”. Applicants assert that neither the Dean reference nor the Korman reference has any teaching or suggestion whatsoever of depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1.

Therefore, any combination of the Dean reference and the Korman reference cannot and does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claims 1 and 11. Accordingly, presently amended independent claims 1 and 11 are allowable as well as dependent claims 2 through 10 and 12 through 20 therefrom.

Obviousness Rejection of Claims 5 and 15 Based on Dean et al. in view of Eizenberg et al., TiCN: A new chemical vapor deposited contact barrier metallization for submicron devices, Appl. Phys. Lett. 65 (19), 7 November 1994, pp. 2416-18 (“Eizenberg”)

Applicants further submit that to establish a *prima facie* case of obviousness under 35 U.S.C. § 103 three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Third, the cited prior art reference must teach or suggest all of the claim limitations. Furthermore, the suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on Applicants’ disclosure.

After reviewing the cited prior art, the rejection, and the Examiner’s comments, Applicants have amended the claimed invention to clearly distinguish over the cited prior art.

Again, turning to the Dean reference, a diffusion barrier layer is taught or suggested comprising titanium carbonitride formed in a chemical-vapor-deposition process. A CVD-deposited layer of the type designated by TiC_xN_y is formed wherein an analysis of the layers indicates that the ratio of x and y are each equal to or approximately equal to 1. More generally, in such layers the ratio is $0.8 < x < 1.2$ and $0.8 < y < 1.2$.

The Eizenberg reference teaches forming a TiCn film using netallorganic precursor.

Applicants assert that any combination of the Dean reference and Eizenberg reference does not and cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claims 1 and 11 because, at the very least, any combination of such cited prior art fails to teach or suggest all of the claim limitations. Applicants assert that any combination of the Dean reference and the Eizenberg reference fails to teach or suggest the claim limitations of presently amended independent claims 1 and 11 calling for ““depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1, the amorphous- titanium carbonitride film lining at least a portion of the sidewall of the contact opening overlaying at least a portion of the titanium metal layer covering the at least a portion of the silicon region exposed by the contact opening”. Applicants assert that neither the Dean reference nor the Eizenberg reference has any teaching or suggestion whatsoever of depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1.

Therefore, any combination of the Dean reference and the Eizenberg reference cannot and does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claims 1 and 11. Accordingly, presently amended independent claims 1 and 11 are allowable as well as dependent claims 2 through 10 and 12 through 20 therefrom.

Obviousness Rejection of Claims 8 and 18 Based on Dean et al. and Eizenberg et al. as applied to claims 5 and 15 above, and further in view of Nulman et al.

Claims 8 and 18 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dean et al. and Eizenberg et al. as applied to claims 5 and 15 above, and further in view of Nulman et al.

Applicants respectfully traverse this rejection, as hereinafter set forth.

Applicants further submit that to establish a *prima facie* case of obviousness under 35 U.S.C. § 103 three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Third, the cited prior art reference must teach or suggest all of the claim limitations. Furthermore, the suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on Applicants' disclosure.

After carefully considering the cited prior art, the rejections, and the Examiner's comments, Applicants have amended the claimed invention to clearly distinguish over the cited prior art.

Again, turning to the Dean reference, a diffusion barrier layer is taught or suggested comprising titanium carbonitride formed in a chemical-vapor-deposition process. A CVD-deposited layer of the type designated by TiC_xN_y is formed wherein an analysis of the layers indicates that the ratio of x and y are each equal to or approximately equal to 1. More generally, in such layers the ratio is $0.8 < x < 1.2$ and $0.8 < y < 1.2$.

The Eizenberg reference teaches forming a TiCn film using netallorganic precursor.

The Nulman et al. reference teaches or suggests the annealing of a titanium layer over a silicon surface, a titanium nitride layer of the titanium layer, a second titanium layer over the titanium nitride layer used as a barrier layer. The titanium nitride layer having crystalline structure.

Applicants assert that any combination of the Dean reference, the Eizenberg reference, and Nulman et al reference does not and cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claims 1 and 11 because, at the very least, any combination of such cited prior art fails to teach or suggest all of the claim limitations. Applicants assert that any combination of the Dean reference, the Eizenberg reference, and Nulman et al reference fails to teach or suggest the claim limitations of presently amended independent claims 1 and 11 calling for ““depositing

an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1, the amorphous titanium carbonitride film lining at least a portion of the sidewall of the contact opening overlaying at least a portion of the titanium metal layer covering the at least a portion of the silicon region exposed by the contact opening”. Applicants assert that neither the Dean reference, nor the Eizenberg reference, nor Nulman et al reference has any teaching or suggestion whatsoever of depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1.

Therefore, any combination of the Dean reference, the Eizenberg reference, and Nulman et al reference cannot and does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claims 1 and 11. Accordingly, presently amended independent claims 1 and 11 are allowable as well as dependent claims 2 through 10 and 12 through 20 therefrom.

Obviousness Rejection of Claims 6 and 16 Based on Dean et al. and Eizenberg et al. as applied to claims 5 and 15 above, and further in view of Dixit et al.

Claims 6 and 16 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dean et al. and Eizenberg et al. as applied to claims 5 and 15 above, and further in view of Dixit et al. Applicants respectfully traverse this rejection, as hereinafter set forth.

Applicants further submit that to establish a *prima facie* case of obviousness under 35 U.S.C. § 103 three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Third, the cited prior art reference must teach or suggest all of the claim limitations. Furthermore, the suggestion to make the claimed

combination and the reasonable expectation of success must both be found in the prior art, and not based on Applicants' disclosure.

After carefully considering the cited prior art, the rejections, and the Examiner's comments, Applicants have amended the claimed invention to clearly distinguish over the cited prior art.

Again, turning to the Dean reference, a diffusion barrier layer is taught or suggested comprising titanium carbonitride formed in a chemical-vapor-deposition process. A CVD-deposited layer of the type designated by TiC_xN_y is formed wherein an analysis of the layers indicates that the ratio of x and y are each equal to or approximately equal to 1. More generally, in such layers the ratio is $0.8 < x < 1.2$ and $0.8 < y < 1.2$.

The Eizenberg reference teaches forming a TiCn film using netallorganic precursor.

The Dixit et al. reference teaches a tungsten and doped polysilicon plug or a uniform dopant distribution as well as annealing a Ti/TiN layer to form a silicide.

Applicants assert that any combination of the Dean reference, the Eizenberg reference, and the Dixit et al. reference does not and cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claims 1 and 11 because, at the very least, any combination of such cited prior art fails to teach or suggest all of the claim limitations. Applicants assert that any combination of the Dean reference, the Eizenberg reference, and the Dixit et al. reference fails to teach or suggest the claim limitations of presently amended independent claims 1 and 11 calling for ““depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1, the amorphous titanium carbonitride film lining at least a portion of the sidewall of the contact opening overlaying at least a portion of the titanium metal layer covering the at least a portion of the silicon region exposed by the contact opening”. Applicants assert that neither the Dean reference, for the Eizenberg reference, nor the Dixit et al. reference has any teaching or suggestion whatsoever of depositing an amorphous titanium carbonitride film having no definite crystalline structure and having virtually no crystalline titanium nitride therein, the

amorphous titanium carbonitride film having a ratio of nitrogen atoms to carbon atoms falling within the range of 5:1 to 10:1.

Therefore, any combination of the Dean reference, the Eizenberg reference, and the Dixit et al. reference cannot and does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claims 1 and 11. Accordingly, presently amended independent claims 1 and 11 are allowable as well as dependent claims 2 through 10 and 12 through 20 therefrom.

In summary for the reasons set forth herein, Applicants submit that claims 1 through 20 are clearly allowable over the cited prior art.

Applicants request the allowance of claims 1 through 20 and the case passed for issue.

Respectfully submitted,



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